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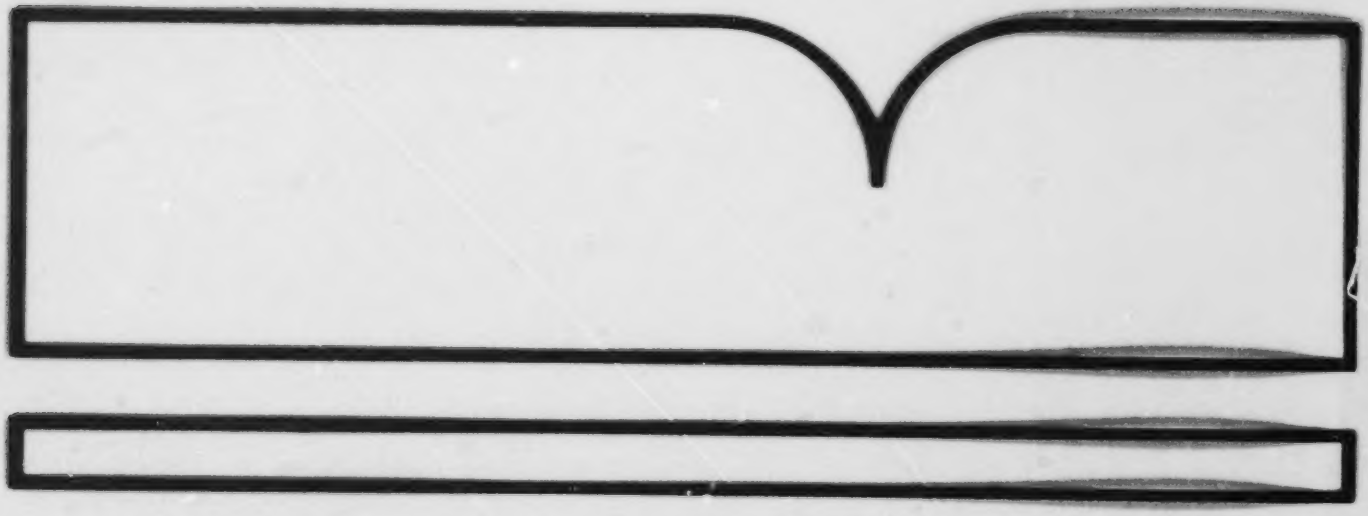
Report to Congress: Solid Waste Disposal in the United States Volume 1

(U.S.) Environmental Protection Agency
Washington, DC

Oct 88



U.S. Department of Commerce
National Technical Information Service
NTIS

United States
Environmental Protection
Agency

Office of Solid Waste
and Emergency Response
Washington, D.C. 20460

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Solid Waste

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EPA

Report to Congress

Solid Waste Disposal in the United States

Volume I

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16. Abstract (Limit: 200 words)

The report presents the results of EPA s study carried out pursuant to Section 4010 of Subtitle D of RCRA, as amended by HSWA. This report addresses the land disposal of all non-hazardous solid waste covered by the existing Federal Subtitle D criteria (40 CFR Part 257). The adequacy of these Federal criteria as well as existing State Subtitle D programs is evaluated. The report is published in two volumes. Volume I contains the Executive Summary and presents the conclusions of the Subtitle D study.

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Section III
RECOMMENDATIONS

A. Introduction

Current data indicate that some municipal solid waste landfills have degraded the environment and present potential risks to human health. As described in the previous section, these impacts are due to both inadequate Federal and State criteria and inadequate State implementation of State regulations. Therefore, recommendations are made for all levels of government. All of the recommendations are aimed at continuing the roles established by the Resource Conservation and Recovery Act (RCRA)--that is, full implementation of the Subtitle D program by the States, with limited Federal involvement.

B. General Recommendations

Federal and State Governments Must Coordinate Subtitle D Waste Management Activities, with States Maintaining the Lead Role in Most Activities.

All levels of government must work closely together in developing effective State and local solid waste management programs. EPA believes the roles of Federal, State, and local government established by RCRA continue to be appropriate. According to RCRA, EPA must establish national criteria and guidelines and offer assistance to the States. In the past several years, there has not been an active Federal Subtitle D program to offer technical assistance and guidelines to the States. In addition, other Federal agencies that carry out solid waste disposal activities or allow other entities to engage in such activities on their land are responsible for ensuring compliance with the Federal criteria.

The State and local roles are to implement the Subtitle D program. The present lack of data for most Subtitle D facilities and the current municipal solid waste capacity crisis indicate that the level of effort spent on Subtitle D must increase. State and local governments, with limited resources, have not been able to focus on Subtitle D waste

management activities. Close coordination among all levels of government will help ensure that an effective solid waste management program is established.

Existing Data Gaps Need to Be Filled.

Data gaps concerning Subtitle D wastes, facilities, and practices need to be filled. Additional survey and characterization studies and health risk assessments are needed. A determination of the extent of harm by Subtitle D wastes to human health and the environment and what controls are needed to avoid further harm is necessary. These data can be collected at the Federal, State, and local level and should be coordinated to avoid duplication of efforts.

The extent of the solid waste disposal problem on all types of Indian lands must be investigated. For this investigation, the definition of "trust and restricted lands" in the Indian Land Consolidation Act (25 USC 2201.4) should be used.

Coordination Among Federal and State Agencies and Indian Tribes Is Needed to Develop an Appropriate Strategy for Solid Waste Management on Indian Lands.

Several Federal agencies and States have been involved to some extent with solid waste disposal on Indian lands. The IHS, EPA, Bureau of Indian Affairs, and Department of Housing and Urban Development (HUD) have provided some technical assistance to Tribes. This assistance has included advice about where to obtain funding, cost estimations, plan development, field work, data collection and evaluation, and training. For example, the assistance offered by the IHS has varied from the provision of garbage cans to the development of a complete collection and disposal system. The specific roles for each Federal agency with respect to management of solid waste on Indian lands must be established to avoid overlap in some areas and lack of attention in other areas. Technical assistance should continue to be provided to Indian Tribes as they develop implementable and environmentally sound solid waste disposal plans and programs. In addition,

Federal agencies, States, and Indian Tribes should develop cooperative arrangements, where appropriate.

A Multi-Faceted Approach to Solid Waste Management Should Be Encouraged.

There is no one solution to Subtitle D waste management problems. Activities should be put in place to encourage and promote integrated waste management including source reduction, recycling and the use of recycled materials, energy recovery, and environmentally sound land disposal for the residual waste. The use of recycling and source reduction techniques has been minimal and should be expanded. Efforts should be taken to reduce the volume of the waste stream (e.g., reduce the use of unnecessary packaging), and reduce the use of potentially hazardous constituents in products. In addition, every effort should be made to improve the recyclability of the Subtitle D waste stream. For example, during the development of new products, the recyclability of the products should be considered. At the same time, energy recovery and land disposal facilities should be carefully located, designed, and operated.

C. Recommendations for Federal Action

EPA Should Revise the Criteria for Municipal Solid Waste Landfills.

Environmental impacts and potential human health impacts have been documented only for municipal solid waste landfills because data for other Subtitle D facilities are insufficient to support such an evaluation. Therefore, EPA believes that, at present, the Federal criteria should be revised only for municipal solid waste landfills. The revised criteria should provide specific performance standards for municipal solid waste landfills that allow for adequate State flexibility. The essential requirements described earlier--namely, those addressing landfill location, design, operation (including, ground-water monitoring and corrective action), and closure and post-closure care (including financial responsibility)--should be included in the revisions.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 7 1988

THE ADMINISTRATOR

Honorable George Bush
President of the Senate
Washington D.C. 20510

Dear Mr. President:

I am pleased to transmit the enclosed Report to Congress on Solid Waste Disposal in the United States. The report presents the results of our study carried out pursuant to Section 4010 of Subtitle D of the Resource Conservation and Recovery Act as amended by the 1984 Hazardous and Solid Waste Amendments.

The report addresses the land disposal of all non-hazardous solid waste covered by the existing Federal Subtitle D criteria (40 CFR Part 257). The adequacy of these Federal criteria as well as existing State Subtitle D programs is evaluated.

The report is published in two volumes. Volume I contains the Executive Summary and presents the conclusions and recommendations of the Subtitle D study. Volume II contains the detailed data collected during the study.

Sincerely,

Lee M. Thomas

Enclosure

The Federal Subtitle D Program Should Reflect the Differences Within the Universe of Subtitle D Wastes and Facilities.

The Subtitle D universe is made up of different types of facilities and wastes, including municipal solid waste landfills, mining waste sites, and industrial facilities. In addition to the obvious differences in physical characteristics, risks posed by municipal solid waste landfills may differ from those posed by other Subtitle D facilities. Therefore, facility-specific regulations commensurate with risks posed should be developed.

In addition to differences in risks posed by these facilities, the regulatory infrastructures pertaining to each facility and waste type vary. At the Federal level, Subtitle D waste streams may be regulated under several different statutes besides RCRA, including the Clean Water Act, the Clean Air Act, and the Toxic Substances Control Act. Likewise, at the State level, regulatory structures and implementation programs often differ for facility types. For these reasons, the Federal Subtitle D program for different waste streams may vary. For example, the program for mining waste may look different from the program for municipal solid waste landfills.

EPA Should Increase Technical Assistance to States and Local Governments.

EPA should disseminate information on various options for all facets of solid waste management. State and local solid waste management officials need up-to-date information to make appropriate decisions. EPA could offer guidance to the States in the form of model certification programs for facility operators and educational programs for local officials and the public on such topics as solid waste management options and associated costs and risks. States also need assistance on how to expedite the siting of new Subtitle D facilities. EPA and the States need to work closely when developing State solid waste management programs. EPA should offer guidance and training to the States to assist in developing appropriate State programs.

EPA Should Promote Source Reduction and Recycling.

As part of EPA's technical assistance to the States, EPA should take steps to promote source reduction and recycling. Source reduction efforts should focus on reduction of both the volume and the toxicity of the waste stream. Current data indicate that only a small percentage of the municipal solid waste stream is currently recycled. Many States are increasing their recycling efforts to help extend landfill life. Technical assistance at the national level is needed. EPA could sponsor recycling forums to help provide up-to-date information to localities across the country. Pilot programs using new technologies could also be conducted by EPA.

The EPA along with other Federal agencies should investigate methods for stimulating the public and industry to reduce wastes. The EPA should conduct studies on current State and community incentive policies for source reductions. The development of procurement guidelines should be hastened so that the Federal market for recycled materials can be improved.

The Federal Government Should Conduct and Sponsor Subtitle D Research.

The Federal government should be responsible for coordinating and conducting research in all areas of Subtitle D waste management. Research is needed on control technologies that can minimize impacts from facilities. In addition, the risks posed by new and developing waste management technologies should be carefully characterized. Careful coordination is necessary to ensure efforts are not duplicated and that all interested parties are aware of the current research projects.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 7 ...

THE ADMINISTRATOR

Honorable James C. Wright
Speaker of the House
of Representatives
Washington D.C. 20515

Dear Mr. Speaker:

I am pleased to transmit the enclosed Report to Congress on Solid Waste Disposal in the United States. The report presents the results of our study carried out pursuant to Section 4010 of Subtitle D of the Resource Conservation and Recovery Act as amended by the 1984 Hazardous and Solid Waste Amendments.

The report addresses the land disposal of all non-hazardous solid waste covered by the existing Federal Subtitle D criteria (40 CFR Part 257). The adequacy of these Federal criteria as well as existing State Subtitle D programs is evaluated.

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Sincerely,

Lee M. Thomas

Enclosure

CONTENTS

SECTIONS		PAGE
	EXECUTIVE SUMMARY	ES-1
I	INTRODUCTION	1
	A. Structure of Subtitle D	2
	B. Scope of the Report	3
	C. Study Methodology	5
II	FINDINGS	10
	A. Profile	10
	B. Impacts	16
	Municipal Solid Waste Landfills	17
	Industrial Subtitle D Facilities	34
	C. Special Subtitle D Wastes	39
	Waste Tires	39
	Infectious Waste	39
	Municipal Solid Waste Combustion Ash	40
	D. Factors Contributing to Impacts	40
	Adequacy of State and Federal Regulations	40
	State Implementation of State Regulations	44
	Federal Technical Assistance	47
III	RECOMMENDATIONS	48
	A. Introduction	48
	B. General Recommendations	48
	C. Recommendations for Federal Action	50
	D. Recommendations for State and Local Action	53
	E. Recommendations for Legislative Changes	54

TABLES		PAGE
1	Subtitle D Waste Categories and Quantities	11
2	Estimated Number of Active Subtitle D Units	13
3	Violations of State Media Protection Standards at Municipal Solid Waste Landfills in 1984	20
4	Wastes Disposed of in a Typical Municipal Solid Waste Landfill	28
5	Design and Operating Controls at Active Municipal Solid Waste Landfill Units	34
6	Number of Industrial Subtitle D Units and 1985 Waste Quantities Disposed of in Them	36
7	Design and Operating Controls Employed at Industrial Subtitle D Facilities	37
8	Violations of State Standards Detected at Industrial Subtitle D Facilities in 1984	38

FIGURES		PAGE
1	Land Disposal Units	4
2	Subtitle D Study Methodology	6
3	Universe of Subtitle D Units, by Percent	14
4	Remaining Life of Municipal Waste Landfills, by Percent (as of 1986)	15

EXHIBITS		PAGE
1	Data Collection Projects	8
2	Household Hazardous Wastes and Their Characteristics	29
3	Categories of Very-Small-Quantity Generator Wastes	31

Executive Summary

Disposal of "nonhazardous" solid waste is regulated under Subtitle D of the Resource Conservation and Recovery Act (RCRA). These Subtitle D wastes include many different types of waste streams, such as municipal solid waste, industrial waste, and oil and gas waste. Recently, concerns have been raised regarding the impacts Subtitle D wastes may be having on human health and the environment. In response to these concerns, Congress, in the 1984 Hazardous and Solid Waste Amendments to RCRA, directed the Environmental Protection Agency (EPA) to evaluate the adequacy of the current Subtitle D regulatory program. This report fulfills this mandate.

The report is published in two volumes. Volume I presents the conclusions and recommendations of the Subtitle D study, and Volume II contains the results of the data collection efforts. Because of data availability, municipal solid waste landfills and the wastes they receive are covered more completely than other facility and waste types. In addition, oil and gas wastes, mining wastes, utility wastes, and municipal sewage sludge are only briefly discussed because they are subjects of other efforts currently being conducted by EPA.

Major Findings

Subtitle D Waste Stream Is Large and Diverse. More Than 11 Billion Tons of Subtitle D Waste Are Produced Annually in the United States. Of this total more than 95 percent are industrial nonhazardous waste, oil and gas waste, mining waste, and municipal solid waste. Each type of waste presents unique management problems and risks.

There Are Many Subtitle D Units. There are 226,732 Subtitle D units in the United States. Eighty-four percent of this total are surface impoundments, 8 percent are land application units, 6 percent are landfills, and 2 percent are industrial waste piles. Of the nearly 13,000 landfill units identified, 6,584 are municipal solid waste landfill units.

Shortages of Municipal Solid Waste Landfill Capacity Are Occurring in Some Areas of the Nation. The shortages are due to several factors: (1) 83 percent of the municipal solid waste generated in 1986 was landfilled; (2) 45 percent of all municipal solid waste landfills will close by 1991; (3) some States have not conducted long-term planning; and (4) siting of new disposal facilities is difficult.

Impacts Have Been Identified For Municipal Solid Waste Landfills. These include:

- Municipal solid waste landfills have degraded and may continue to degrade the environment.

- Human health impacts from exposure to ground-water contamination caused by municipal solid waste landfills have not been documented. However, taken as a whole, the data indicate that releases to the ground water from municipal solid waste landfills present potential risks to human health.

- Acute human health impacts associated with methane releases have been documented.

- The Agency is currently determining the extent of human health risks that may result from emissions of volatile organic compounds.

- Indian Tribes perceive that municipal solid waste disposal is an environmental problem on Indian lands.

Data Are Insufficient to Support A Conclusion Regarding Impacts At Industrial Subtitle D Facilities. However, the limited available data on industrial Subtitle D facilities indicate that there is cause for concern and a need for further study. Current findings include: (1) the use of design controls at industrial facilities is very limited; (2) the number of industrial facilities is large and the amount of industrial nonhazardous waste generated annually dwarfs the amount of municipal solid waste; and (3) violations of State standards have been documented. EPA will be able to better define the impacts of industrial waste facilities after additional data are available.

Several Subtitle D Waste Streams Pose Special Management Concerns. Waste tires, infectious waste, and municipal waste combustion ash are examples of special Subtitle D wastes. The special management concerns posed by these waste streams arise from the unique characteristics of these wastes. Current data are not sufficient to estimate reliably the risks posed by these wastes.

Existing Federal and State Subtitle D Regulations Are Inadequate. Federal and some State solid waste regulations lack the following essential requirements: location criteria, appropriate design criteria, ground-water monitoring, corrective action, closure and post-closure care, and financial responsibility.

State Implementation of State Regulations Is Inadequate. The following State program inadequacies were found: incomplete enforcement authorities, fragmented organization, limited resources, and a lack of long-term planning.

Since 1980, Very Limited Technical Assistance on Solid Waste Management Has Been Offered by the Federal Government to State and Local Governments. The last Agency guidance document on solid waste management was issued in 1979.

Recommendations

EPA Makes the Following General Recommendations:

- The roles established by RCRA for Federal, State, and local governments should be continued, with responsibility for implementing the Subtitle D program mostly with State and local governments.

- An integrated waste management system including: source reduction, recycling, energy recovery, and environmentally sound land disposal for the residual wastes should be promoted.

- Coordination among Federal and State agencies and Indian Tribes is needed to develop an appropriate strategy for solid waste management on Indian lands.

- Data gaps, particularly for industrial waste facilities need to be filled. Additional survey and characterization studies as well as health risk assessments are necessary.

With Respect to Federal Activities EPA Recommends the Following:

- The current Federal Subtitle D criteria should be revised for municipal solid waste landfills.

- Technical assistance to States and local governments should be increased and should include an emphasis on source reduction and recycling.

- Subtitle D regulatory programs established by the Federal government should be commensurate with risks posed by each waste stream or facility type.

For State and Local Programs, EPA Recommends the Following:

- State and local governments should ensure the vitality of their Subtitle D programs by establishing a dependable future source of funding and strengthening enforcement authorities.

- More long-term planning for solid waste management should be conducted by State and local governments.

- The States must quickly adopt the new Federal criteria for municipal solid waste landfills, as required by the 1984 Hazardous and Solid Waste Amendments.

EPA Recommends the Following Legislative Changes:

- EPA's authority for developing standards under Subtitle D for closed solid waste disposal facilities should be clarified.

- The definition of Indian Tribes under RCRA should be amended to include provisions similar to those under the Safe Drinking Water Act.

- Data are insufficient to indicate the need for any additional enforcement authorities beyond those provided by HSWA for solid waste disposal facilities that receive household hazardous waste and small-quantity generator hazardous waste.

Section I
INTRODUCTION

Recently, disposal of "nonhazardous" solid waste, regulated by Subtitle D of the Resource Conservation and Recovery Act (RCRA), has received increased national attention. Several billion tons of these "Subtitle D wastes" -- which include municipal solid waste, oil and gas waste, and industrial waste -- are generated each year.

Municipal solid waste, in particular, has received national attention in the last several years. This attention is mainly due to the rapid depletion of existing landfill capacity in certain areas, the increasing public concern regarding safe siting and design of new disposal facilities, and the resulting difficulty municipalities are having deciding what to do with the trash generated in their communities.

This heightened awareness of Subtitle D wastes has raised concerns regarding the impacts these waste streams may be having on human health and the environment. Because of these concerns, Congress, in the 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA, directed the Environmental Protection Agency (EPA) to evaluate the adequacy of the Subtitle D regulatory program and to develop recommendations for improvements, if necessary. This report fulfills this mandate and provides a detailed description of the land disposal of Subtitle D wastes in the United States.

EPA believes the Subtitle D regulatory program must be a viable and protective alternative to the comprehensive hazardous waste regulatory program currently in place under Subtitle C of RCRA. Without a strong Subtitle D program, increased public concern about nonhazardous solid waste may drive more and more of these waste streams to regulation under the hazardous waste program. The Subtitle D program encompasses a wide variety of waste streams and disposal facilities that pose different risks. EPA believes that regulatory requirements should be developed that are commensurate with the risks presented. This study is a critical step toward providing that protective alternative.

This report is published in two volumes. Volume I presents the key findings and recommendations of the study. Volume II summarizes the data collected during the study and used to support the findings and recommendations in Volume I. Volume II discusses the background of Subtitle D of RCRA, the study methodology, the data collection projects, Subtitle D wastes, Subtitle D facilities, and Subtitle D State programs.

A. Structure of Subtitle D

Subtitle D of RCRA establishes a framework for coordinating Federal, State, and local governmental management of Subtitle D wastes. EPA's role is to establish the regulatory direction and provide technical assistance to States and territories (herein referred to as States) for planning and developing environmentally sound waste management practices. The actual planning and implementation of Subtitle D waste programs are State and local functions.

Subtitle D of RCRA originally required EPA to (1) promulgate guidelines to assist States in developing and implementing solid waste management plans and (2) establish criteria that provide minimum national performance standards for the protection of human health and the environment from Subtitle D waste disposal facilities. The guidelines (40 CFR Part 256) and the criteria (40 CFR Part 257) were both issued in 1979.

State solid waste management plans are the primary means of implementing the current Federal criteria. Through these plans, States identify an overall strategy for protecting human health and the environment from Subtitle D waste disposal facilities. States are not required to develop these plans; however, States are not eligible for Federal financial assistance unless they have EPA approved solid waste management plans. In 1981, Federal financial assistance was terminated, eliminating an incentive for States to develop and submit plans for EPA approval. To date, EPA has approved 25 State solid waste management plans.

HSWA modified certain aspects of Subtitle D. Besides requiring this study of the current Subtitle D regulatory program, HSWA requires EPA to

revise the current criteria for facilities that may receive household hazardous waste or small-quantity generator hazardous waste. Each State must develop an appropriate permit program or other system of prior approval for facilities covered by the revised criteria. Finally, HSWA gives EPA the discretionary authority to enforce the revised criteria in States that have not developed an adequate enforcement program, thus creating a new Federal enforcement role.

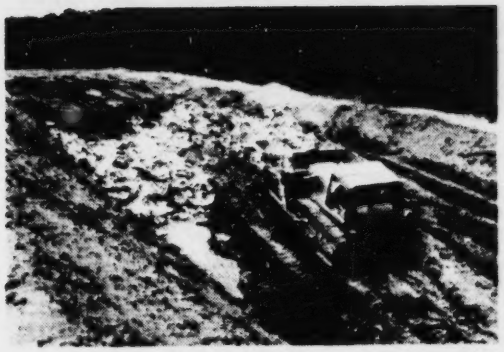
B. Scope of the Report

Because this report focuses on the land disposal of wastes covered by the current Federal Subtitle D regulatory program, it necessarily addresses the following Subtitle D solid waste disposal facilities: landfills, waste piles, land application units, and surface impoundments (see Figure 1). Although this study did not evaluate other waste management methods, such as incineration and recycling, EPA's recently formed Municipal Solid Waste Task Force, will evaluate all methods in its development of a national strategy for managing municipal solid wastes. The Task Force is expected to issue its report in December 1988. In addition, in accordance with the United States - Japan Fishery Agreement Approval Act, enacted in December 1987, EPA is preparing a report to Congress on plastics and plastic recycling that is anticipated to be completed in the summer of 1989.

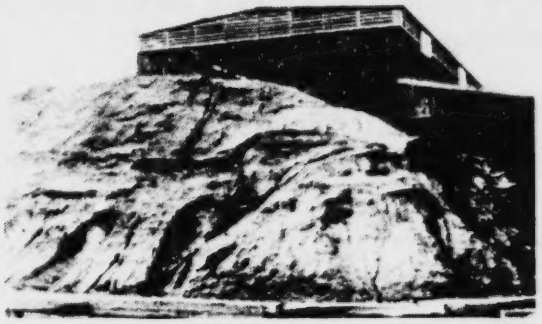
This report addresses all Subtitle D wastes. However, because of data availability, municipal solid waste and industrial waste are discussed more completely than other waste types. While this report presents some limited information regarding other waste types, such as construction and demolition waste and agricultural waste, the data are insufficient to support conclusions concerning impacts on human health or the environment.

Four broad categories of Subtitle D wastes -- waste from the exploration, development, and production of oil and gas, mining waste, waste from coal-fired electric utility plants, and municipal sewage sludge-- are the subject of other efforts currently being conducted by EPA. Municipal sewage sludge and mining waste are the subjects of separate rulemaking efforts, and oil and gas waste and utility waste are the subjects of recently completed reports to Congress. Accordingly they are only briefly discussed in this report.

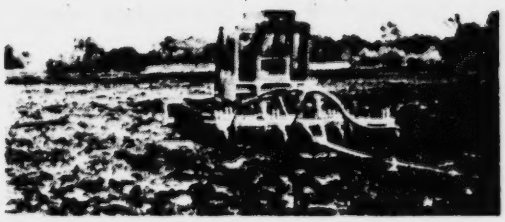
Figure 1. LAND DISPOSAL UNITS



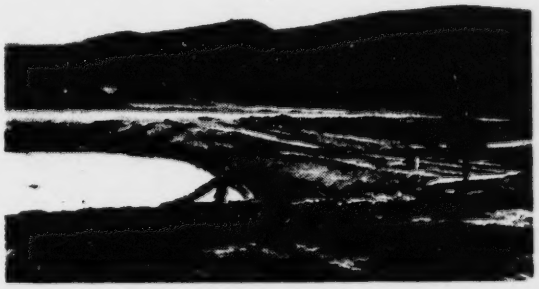
Landfill - facility where wastes are placed in or on the land for permanent disposal.



Waste Pile - mass of solid non-flowing waste material that can function as treatment or storage.



Land Application Unit (land treatment, land farming, and land spreading) - area of land where wastes are applied onto or incorporated into the soil for the purpose of beneficial use or waste treatment and disposal.



Surface Impoundment (pit, pond, or lagoon) - natural topographic depression, man-made excavation, or diked area that is designed to hold an accumulation of liquid wastes.

C. Study Methodology

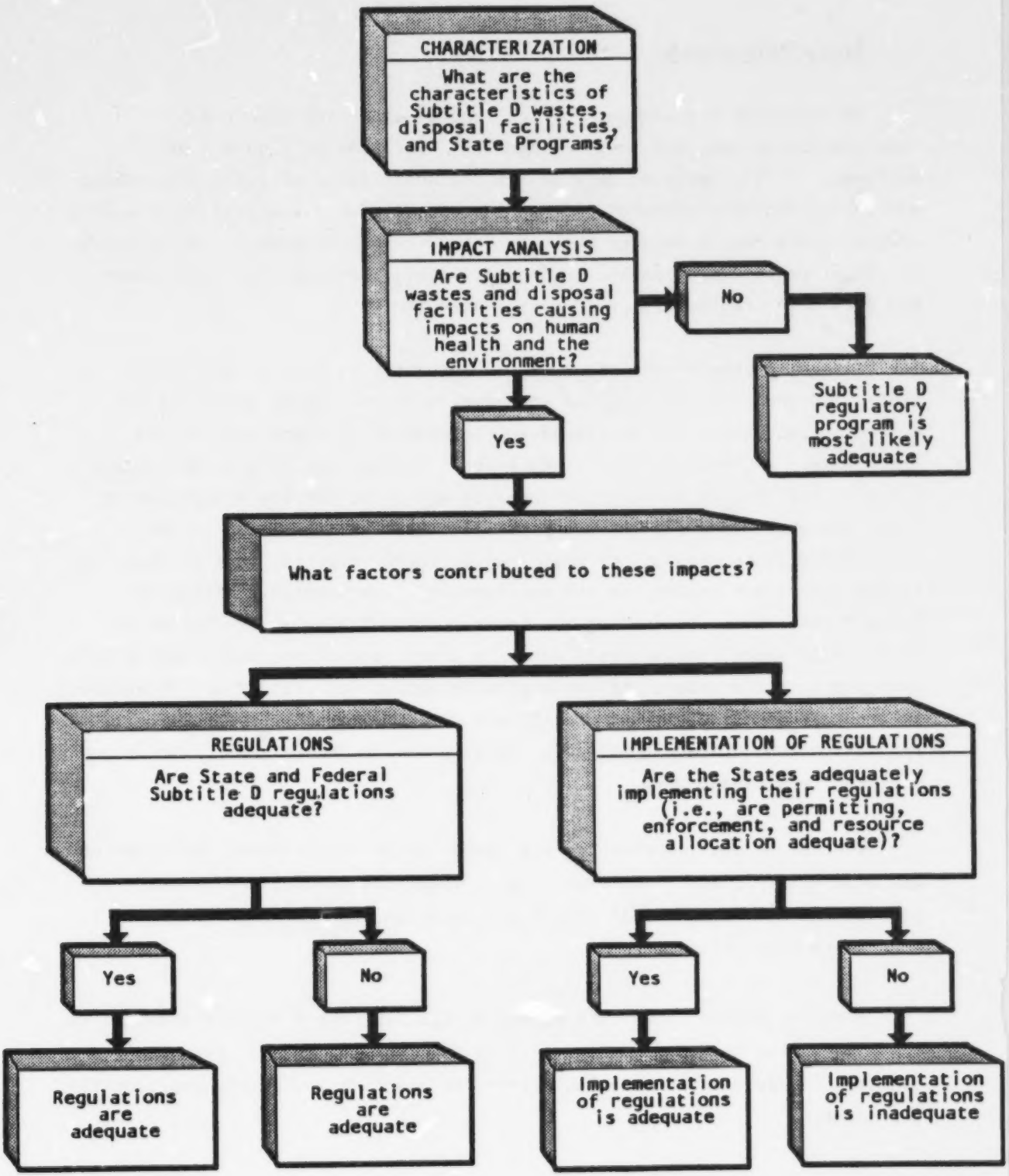
To determine the adequacy of the Federal and State Subtitle D regulatory programs, the study methodology depicted in Figure 2 was followed. First, detailed data on the characteristics of Subtitle D wastes and facilities were gathered. Second, these data were analyzed to determine whether there are impacts on human health or the environment. The presence of actual or potential damage would most likely indicate that some aspect of the Subtitle D regulatory program is inadequate.

The third step of the study was to characterize Federal and State Subtitle D programs (in light of the results of the impact analysis) to determine possible areas of inadequacy in Federal or State regulations and/or State implementation of regulations. The current Federal Subtitle D criteria are minimum national performance standards for the protection of human health and the environment from solid waste disposal facilities. State solid waste regulations must include these criteria, at a minimum, to ensure that human health and the environment are protected. Therefore, EPA's first step in evaluating the Federal criteria was an evaluation of State solid waste regulations. Adequate State regulations would most likely indicate that the Federal criteria provide appropriate regulatory direction to ensure protection of human health and the environment. Inadequate State regulations would suggest possible inadequacies in the Federal criteria and the need to evaluate them.

Whether or not inadequacies are found in the regulations, deficiencies may also exist in State implementation. Thus, the adequacy of State permitting, enforcement, and resource allocation was evaluated concurrently with State regulations.

Finally, another important aspect of the Subtitle D program analyzed in this study (not depicted in Figure 2) is the level of Federal technical assistance made available to the States for planning and developing Subtitle D programs.

Figure 2. SUBTITLE D STUDY METHODOLOGY


CHARACTERIZATION
What are the characteristics of Subtitle D wastes, disposal facilities, and State Programs?
IMPACT ANALYSIS
Are Subtitle D wastes and disposal facilities causing impacts on human health and the environment?
No
Subtitle D regulatory program is most likely adequate
Yes
What factors contributed to these impacts?
REGULATIONS
Are State and Federal Subtitle D regulations adequate?
IMPLEMENTATION OF REGULATIONS
Are the States adequately implementing their regulations (i.e., are permitting, enforcement, and resource allocation adequate)?
Yes
No
Yes
No
Regulations are adequate
Regulations are adequate
Implementation of regulations is adequate
Implementation of regulations is inadequate

The major studies EPA conducted to characterize Subtitle D waste, facilities, and State programs are listed in Exhibit 1. Information for these studies was obtained from State and EPA files, voluntary submissions by facility owners and operators, and published and unpublished literature.

Exhibit 1. DATA COLLECTION PROJECTS

Subtitle D Waste Characterization Studies:

A Survey of Household Hazardous Wastes and Related Collection Programs
- Review of existing data on the characteristics of HHW and analysis of HHW collection programs

Characterization of Municipal Solid Waste in the United States, 1960 to 2000
- Inventory and forecast of municipal solid wastes in the U.S.

Hazardous Waste Generator Data and Characteristics of Sanitary Landfills in Selected Counties in Florida
- Case history of Florida disposal of small quantity generator hazardous wastes

National Small Quantity Generator Survey
- Survey to characterize SQG waste volumes and disposal practices

Source, Availability, and Review of RCRA Subtitle D Land Disposal Data Published Since 1980
- Reviews and abstracts of recent literature relevant to the Subtitle D study

Summary of Data on Industrial Nonhazardous Waste Disposal Practices
- Summary of non-State data on solid waste characteristics and solid waste disposal practices

Subtitle D Facility Characterization Studies:

Census of State and Territorial Subtitle D Nonhazardous Waste Programs
- Mail survey of data on State Subtitle D programs and Subtitle D facilities

Critical Review and Summary of Leachate and Gas Production from Landfills
- Summary and evaluation of data on quality of leachate from municipal landfills

Evaluation of a Landfill with Leachate Recycle
- Case study of the Lycoming County, PA, landfill with a major emphasis on experiences with leachate recirculation

Evaluation of NPL/Subtitle D Landfill Data
- Summary of data on former Subtitle D facilities that are now on the NPL or are candidates for the NPL

Gas Characterization, Microbiological Analysis, and Disposal of Refuse in GRI Landfill Simulators
- GC/MS analysis of landfill gas samples from the Center Hill lysimeters

Ground-Water and Surface Water Contamination from Municipal Solid Waste Landfills
- Summary of facility characteristics and environmental impacts at the damage cases

Industrial Facilities Telephone Survey
- Summary of data from a telephone survey of 17 industries

Landfill Gas Update: Summaries of Technical Reports
- Summaries of six studies relating to landfill gas production, characteristics, and recovery

Leachate Baseline Report
- Review of municipal landfill leachate data compiled from existing literature sources

Municipal Solid Waste Landfill Survey
- Summary of data from State survey of municipal landfills

Exhibit 1. DATA COLLECTION PROJECTS (Continued)

State Subtitle D Program Characterization Studies:

National Solid Waste Survey (ASTSWMO)
-- Mail survey of data on State Subtitle D program

Review of State Enforcement Authorities Under RCRA Subtitle D
-- Compilation of data on States' enforcement authorities with respect to Subtitle D management and disposal facilities

State Regulatory Equivalency Analysis of the U.S. EPA Classification Criteria for Solid Waste Disposal Facilities (40 CFR Part 257)
-- A State by State determination of the comparability of State Subtitle D regulations to those contained at 40 CFR Part 257

State Subtitle D Regulations on Municipal Waste Landfills, Surface Impoundments, Waste Piles and Land Application Units
-- Review of State Subtitle D regulations

Updated Review of Selected Provisions of State Solid Waste Regulations
-- A review of liner, leachate collection, final cover, ground-water monitoring and corrective action requirements

SOURCE: Chapter 2 of Volume II of this report.

Section II
FINDINGS

This section provides a profile of Subtitle D facilities, describes impacts associated with these facilities, and reports on the status of governing Federal and State regulatory programs. A more detailed description and characterization of the wastes and facilities as well as the supporting references are presented in Chapters 3 and 4 of Volume II.

A. Profile

The Subtitle D Waste Stream Is Large and Diverse.

As shown in Table 1, more than 11 billion tons of Subtitle D waste are produced annually. Industrial nonhazardous waste accounts for the largest portion of this total, followed by oil and gas waste and mining waste. Municipal solid waste, the fourth largest category, is expected to increase 20 percent by the year 2000.

Table 1 also shows that the Subtitle D waste stream is very diverse. Such different waste types as waste tires, infectious waste, industrial nonhazardous waste, and municipal solid wastes are all regulated under Subtitle D of RCRA. Furthermore, some of the Subtitle D waste types listed in Table 1 are broad categories that include a variety of waste streams. For example, the industrial nonhazardous waste category includes wastes from the pulp and paper industry, the organic chemical industry, the textile manufacturing industry, and a variety of other industries. In addition, a wide range of Subtitle D wastes are produced within each industrial sector. These waste streams may vary in chemical composition and/or physical form.

Each Subtitle D waste type presents unique problems and risks. For example, waste tires pose management concerns that are significantly different from those posed by mining waste or industrial waste. Each waste stream must be carefully evaluated to determine the most appropriate management option.

Table 1. SUBTITLE D WASTE CATEGORIES AND QUANTITIES

Waste Category	Estimated Annual Generation Rate (million tons)
Industrial Nonhazardous Waste	7,600[a,b]
Oil and Gas Waste[c]	
- drilling waste	129 - 871[d,e]
- produced waters	1,966 - 2,738[e,f]
Mining Waste[c]	>1,400[g]
Municipal Solid Waste	158[b]
- household hazardous waste	0.002 - 0.56[b]
Municipal Waste Combustion Ash	3.2-8.1[h]
Utility Waste[c]	
- ash	69[i]
- flue gas desulfurization waste	16[i]
Construction and Demolition Waste	31.5[j]
Municipal Sludge	
- wastewater treatment	6.9[b]
- water treatment	3.5[b]
Very-Small-Quantity[b] Generator Hazardous Waste (<100 kg/mo)	0.2[e]
Waste Tires	240 million tires[g]
Infectious Waste	2.1[e,l]
Agricultural Waste	Unknown
Approximate Total	**>11,387**

SOURCE: Chapter 3 of Volume II of this report.

a Not including industrial waste that is recycled or disposed of off site.
b These estimates are derived from 1986 data.
c Waste category is the subject of a separate report to Congress.
d Converted to tons from barrels: 42 gals = 1 barrel, ~17 lbs/gal.
e These estimates are derived from 1985 data.
f Converted to tons from barrels: 42 gals = 1 barrel, ~8 lbs/gal.
g These estimates are derived from 1983 data.
h This estimate is derived from 1988 data.
i These estimates are derived from 1984 data.
j This estimates is derived from 1970 data.
k Small quantity generators (100-1,000 kg/mo waste) have been regulated under RCRA, Subtitle C, since October 1986. Before then, approximately 830,000 tons of small-quantity generator hazardous wastes were disposed of in Subtitle D facilities every year.
l Includes only infectious hospital waste.

There Are Many Subtitle D Facilities.

This study estimates that there are 226,732 Subtitle D units located at approximately 128,000 establishments. (An establishment may have more than one unit.) Of these units, 84 percent are surface impoundments, 8 percent are land application units, 6 percent are landfills, and 2 percent are industrial waste piles (see Table 2 and Figure 3). More than half the units are oil and gas surface impoundments. Municipal solid waste landfills account for nearly half of the landfills and more than two-thirds of the land application units are municipal sewage sludge units. The States estimated that in 1984 there were 33,000 establishments containing only closed or inactive Subtitle D units.

Because Subtitle D units accept several different categories of waste, they differ significantly in design and operation. For example, proper design and operation of municipal sewage sludge surface impoundments may significantly differ from that of oil and gas surface impoundments. Available data for each type of Subtitle D unit are provided in Chapter 4 of Volume II.

Both Public and Private Entities Own and Operate Subtitle D Facilities.

Subtitle D facility owners and operators are responsible for the design and operation of their facilities and any problems that arise. Most of the Subtitle D facilities are privately owned. This is because of the overwhelming number of privately owned oil and gas, industrial, and mining waste facilities. In addition, approximately 17 percent of municipal solid waste landfills are privately owned. However, municipal solid waste landfills are predominantly publicly owned. Nearly 78 percent of municipal solid waste landfills are owned by local governments, approximately 4 percent by the Federal government, and 1 percent by State governments.

The majority of Subtitle D facilities are both owned and operated by the same entity (e.g., a local government). However, some facility owners "contract out" the operation of their facility. For example, approximately 5 percent of publicly owned municipal solid waste landfills are operated by

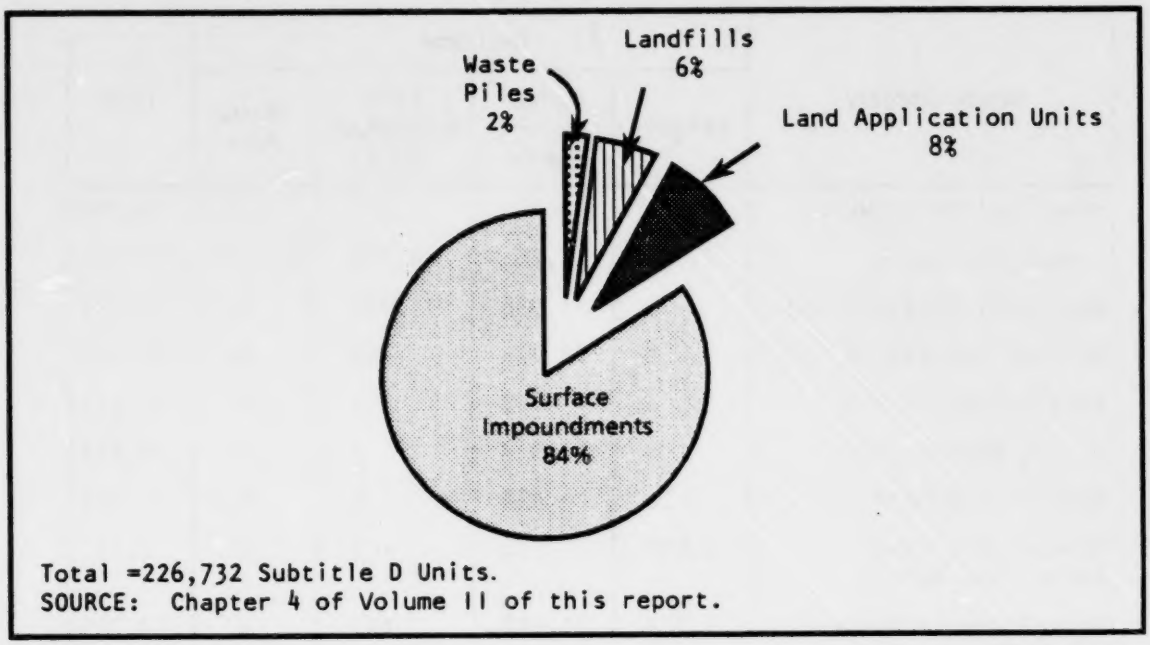
Table 2. ESTIMATED NUMBER OF ACTIVE SUBTITLE D UNITS

Waste Category	Unit Type				Total
	Landfills	Surface Impound-ments	Land Application Units	Waste Piles	
Municipal Solid Waste	6,584[a]	b	b	b	6,584
Industrial Waste	2,757[c]	15,253[c]	4,308[c]	5,335[c]	27,654
Municipal Sewage Sludge	d	1,938	11,937	b	13,875
Oil and Gas Waste[e]	b	125,074	726	b	125,800
Agricultural Waste	d	17,159	b	b	17,159
Mining Waste[e]	d	19,813	b	d	19,813
Municipal Runoff	b	488	b	b	488
Construction and Demolition Debris	2,591	b	b	d	2,591
Miscellaneous Waste	1,030	11,118	621	d	12,769
Appropriate Total Number of Units	**12,962**	**190,843**	**17,592**	**5,335**	**226,732**

SOURCE: Chapter 4 of Volume II of this report.

[a] The results of a previous census of the States indicated 9,300 municipal solid waste landfills. However, the table entry is considered more accurate. It is based on a 1986 Survey.
[b] Unknown, none or few thought to exist.
[c] These estimates differ from previously published results from a census of the States. Table entries are considered to be more accurate. They are based on a 1986 Industrial Survey.
[d] Unknown, some may exist.
[e] Waste category is the subject of a separate report to Congress.

Figure 3. UNIVERSE OF SUBTITLE D UNITS, BY PERCENT



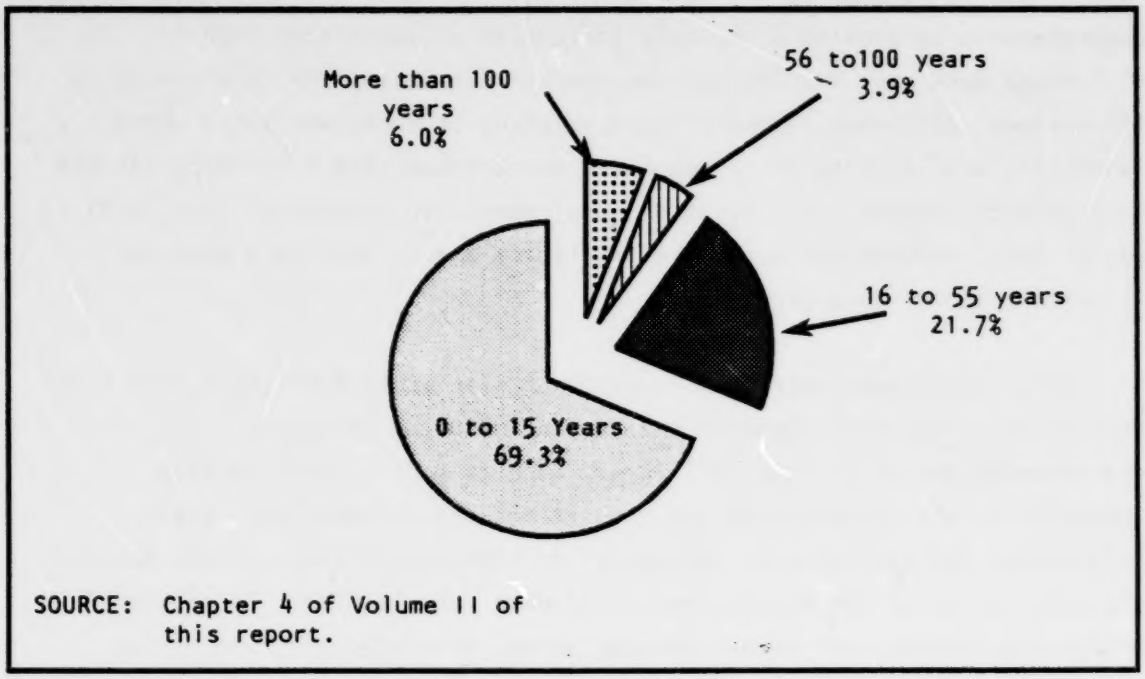
Total =226,732 Subtitle D Units.
SOURCE: Chapter 4 of Volume II of this report.

private entities. In addition, certain Federal agencies lease land to local governments for the operation of municipal solid waste landfills. Congress has recently expressed concern about the control of solid waste disposal facilities on Federal lands. Volume II of this report presents more detailed information on the characteristics of Federally-owned disposal facilities.

Landfilling of Most Municipal Solid Waste Has Caused Capacity Shortages in Some Areas.

Approximately 83 percent of the municipal solid waste generated in 1986 was disposed of in landfills, while only 11 percent was recycled, and only 6 percent was combusted. Extensive reliance on land disposal for municipal solid waste has resulted in capacity shortages in some areas of the nation. Nearly three-fourths (74 percent) of all municipal solid waste landfills are expected to close within 15 years, with 45 percent expected to close in 5 years (see Figure 4). These shortages are becoming critical in densely populated areas of the country, particularly in the Northeast. In addition to limited source reduction and recycling, other factors that appear to be

Figure 4. REMAINING LIFE OF MUNICIPAL SOLID WASTE LANDFILLS, BY PERCENT (as of 1986)



SOURCE: Chapter 4 of Volume II of this report.

contributing to the capacity problem include difficulty in siting new disposal or treatment facilities due to public concerns and limited long-term planning by some State and local governments.

Large Data Gaps Remain and Continue to Be Investigated.

Although this study identified and characterized many Subtitle D facilities and wastes, many data gaps still exist. Municipal solid waste landfills and the wastes they receive have been characterized reasonably well, and some impacts associated with municipal solid waste landfills have been identified. However, leachate and gas data for these facilities are limited.

Comparatively less is known about industrial wastes and facilities. Specific industrial waste streams have not been well characterized and little is known about the hazards they may pose. Data on the number and type of industrial facilites were gathered, but only limited data are

readily available regarding the design, operation, and location of these facilities. Furthermore, the data that are available are not sufficiently comprehensive to provide a reliable indication of associated impacts. To fill these data gaps and improve the overall data base, EPA is planning to (1) conduct additional leachate field sampling at municipal solid waste landfills, and (2) propose to amend the current Subtitle D Criteria (40 CFR Part 257) to include a notification requirement for industrial facilities to gather basic information for these facilities and to develop a plan for filling remaining data gaps.

Very little data were readily available for other Subtitle D wastes and facilities. The broad scope of the report inhibited the full characterization of certain facilities, such as agricultural surface impoundments and construction and demolition debris landfills. Basic information was available on the number of these facilities and the general characteristics of the wastes, but field data were lacking. As mentioned previously, wastes such as oil and gas waste, utility waste, and mining waste are not fully characterized in this report because they are the subjects of other Agency efforts.

B. Impacts

This study assessed the impacts associated with Subtitle D facilities as a second step in evaluating the current Federal Subtitle D criteria. Impacts associated with municipal solid waste landfills and industrial Subtitle D facilities are described separately in this section.

Available data indicate that releases to ground water from some municipal solid waste landfills have degraded and may continue to degrade the environment. While the data do not directly document that releases to ground water from municipal solid waste landfills are currently harming human health, taken as a whole, the data indicate that some municipal solid waste landfills present potential risks to human health. Human health impacts from exposure to contaminant releases to ground water from municipal solid waste landfills are difficult to isolate due to the complex interaction of factors that affect human health. With regard to air

emissions from municipal solid waste landfills, acute impacts associated with methane releases have been documented. The Agency is currently determining the extent of human health risks that may result from emissions of volatile organic compounds, which have been estimated to be in the range of 200,000 megagrams per year. The Agency plans to propose appropriate standards controlling emissions of volatile organic compounds from landfills under Section 111 of the Clean Air Act; a quantitative assessment of the risks will be presented in the proposed rule package.

The number of industrial facilities is very large, as is the amount of waste they handle. Because current data are limited, it is not possible to draw conclusions regarding the risks posed by these facilities. Existing data however, do suggest that these facilities need to be further investigated to determine the need for additional regulatory action.

Municipal Solid Waste Landfills

In examining the impact of municipal solid waste landfills on human health and the environment, EPA gathered and analyzed case study evidence, leachate and waste characterization data, and design, operation, and location information and then performed a risk characterization study. Although the current Federal criteria became effective late in 1979, EPA used some data from sites that were in operation before then. Data on post-1980 facilities are very limited. (These newer sites represent only 30 percent of the municipal solid waste landfills in existence today.) EPA believes this reliance on older data is justifiable for several reasons. First, existing solid waste disposal sites were not exempt from the 1979 criteria. As such, the 1979 criteria should have included all the necessary provisions to address existing facilities.

Second, on a national basis, EPA found little difference in the location, design, and operation of newer municipal solid waste landfills versus older landfills. In terms of location characteristics, EPA found no real reduction in the siting of municipal solid waste landfills in sensitive hydrologic areas over the last twenty years, or in a comparison of pre- to post-1980 facilities. There was no decrease in sitings in karst terrain or

below the seasonal high-water table; approximately 5 percent of both pre- and post-1980 landfills were sited in karst terrain or below the seasonal high-water table. Also, while there was a very slight decrease in sitings in wetlands (always remaining below 5 percent), there was a slight increase in the sitings in floodplains--from about 10 percent of the landfills that opened in the 1970s to about 14 percent of the landfills that opened in the early 1980s.

The use of engineering/design controls at municipal solid waste landfills has increased only slightly over the last 20 years. Through the first half of the 1980's, EPA found an increase in the number of landfills that employ leachate collection systems (about 18 percent of post-1980 landfills) when compared to the previous decade (about 11 percent of landfills that opened in the 1970s). EPA also found an increase in the number of landfills that employ some type of surface water run-on/run-off control system, with about 50 percent of the landfills 15 to 20 years old reporting no system, decreasing steadily to about 25 percent for landfills built in the 1980s. A similar trend was found for landfills employing some type of liner system. A 1986 survey of municipal solid waste landfill operators indicated that 44 percent of the pre-1980 landfills had no liner system, decreasing to about 25 percent among the post-1980 landfills. (These data conflict with data from a 1984 survey of the States. The States reported that 85 percent of the existing municipal solid waste landfills had no liner system. The Agency believes this discrepancy is due to the broad definition given to "natural liners" by the municipal solid waste landfill operators who were surveyed.) Furthermore, the 1986 survey indicates no noticeable trend in the number of landfills employing synthetic membrane liners, with about 1 percent to 2 percent of the landfills less than 20 years old employing this type of liner.

To examine the differences in operation at newer versus older municipal solid waste landfills, EPA looked at the number of facilities that conducted environmental monitoring. For new municipal solid waste landfills, EPA found no increase in the number that monitor surface water or air releases, remaining about 15 percent and 3 percent, respectively. There was a small increase in the number of new landfills that monitor landfill gas (from about 7 percent of the facilities that opened in the 1970s to about 9

percent of the facilities that opened in the 1980s). There was a definite increase in the number of new landfills that monitor ground water (from about 38 percent of the landfills that opened in the 1970s to about 49 percent of the landfills that opened in the 1980s). It is important to note that these trends in landfill gas and ground-water monitoring between the pre- and post-1980s facilities are really part of longer-term trends in the increased use of these types of monitoring and, therefore, may not be the result of any specific regulatory requirements.

The third and final reason why EPA believes the use of older data is justifiable is based on leachate and waste characteristic data. Although the Federal hazardous waste regulations promulgated in 1980 prohibited large-quantity generators of hazardous waste from placing their waste in municipal solid waste landfills, they did not prohibit the placement of very-small-quantity generator and household hazardous waste in these landfills. Some large-quantity generators may also be illegally disposing of their hazardous wastes in municipal solid waste landfills. In addition, a review of the current limited data on leachate from municipal solid waste landfills did not identify any differences in quality between leachates from newer and older landfills. Therefore, although data limitations prohibited a rigorous examination of the differences in the characteristics of the wastes disposed of at newer and older landfills, these limited data do indicate that it is reasonable to use data on older landfills for a gross examination of the potential impacts of newer landfills.

The following are descriptions of the impacts EPA has identified at municipal solid waste landfills.

Violations of State Regulations Demonstrate Environmental Impacts and Potential Human Health Impacts.

Table 3 illustrates the number of violations of State standards detected in 1984 at municipal solid waste landfills. EPA cannot at this time reliably correlate violations with facility age. As shown in Table 3, ground-water violations were found at roughly 6 percent (586) of all municipal solid waste landfills reported in 1984 by the States (9,284). However, the States reported that in 1984 ground-water monitoring was conducted at only about 25 percent of the municipal solid waste landfills.

Table 3. VIOLATIONS OF STATE MEDIA PROTECTION STANDARDS AT MUNICIPAL SOLID WASTE LANDFILLS IN 1984[a]

Medium of Concern	Number of Facilities With at Least One Violation	Facilities with Monitoring	
		Number	Percent
Ground Water	586	2,331	25
Surface Water	660	1,100	12
Air	845	358	4
Methane (subsurface gas)	180	427	5

SOURCE: Chapter 4 of Volume II of this report.

a Includes 9,284 municipal solid waste landfills identified by the 1984 State census.

(The results of a 1986 survey of municipal solid waste landfill owners and operators indicated that approximately one-third of the landfills monitored ground water.) Assuming that these violations were detected by ground-water monitoring systems at the landfill (although violations can sometimes be found through other means, such as a private drinking water well), it can be inferred that violations were detected at 25 percent of the landfills that monitored ground water. The actual number of facilities with ground-water violations can only be determined with more ground-water monitoring.

Because the definition of "violation" differs from State to State, it is not a given that each violation represents a direct or potential risk to human health or the environment. However, it is reasonable to believe that States have established ground-water standards that, when exceeded, indicate a potential loss of resource or a threat to human health if the water is consumed. In fact, some States have established maximum contaminant levels (EPA's drinking water criteria) as ground-water protection standards.

Violations were detected in other media as well. In fact, the number of surface water and air violations were each reported to be greater than the number of ground-water violations. However, it is likely that the majority of air violations were odor-related incidents. Methane violations, on the other hand, raise particular concern due to the potential problems associated with uncontrolled releases (e.g., explosions). It is unknown

how many of the air violations were associated with dangerous methane levels. Correlations between the number of facilities with monitoring and the number of facilities with air or surface water violations are tenuous because some of these violations (i.e., odor nuisances) may be detected without monitoring.

Damage Cases Provide Examples of Environmental and Acute Human Health Impacts.

Case Studies of Ground-Water and Surface Water Resource Damage and Ecological Damage

To date, environmental impacts and threats to human health have been documented at 163 municipal solid waste landfills. These case studies are good examples of problems that can occur at poorly designed and operated landfills. Although most of the documented damages are from landfills that began operation prior to 1980, for reasons described above, these damage cases may also be used to indicate potential problems at post-1980 municipal solid waste landfills.

Ground-water and surface water quality were adversely affected at 146 and 73 municipal solid waste landfills, respectively. While the impacts identified range in severity, 33 sites have contaminated drinking water resources, and three other sites pose a threat to water supply systems. For example, one active municipal solid waste landfill has contaminated a square mile of a sole-source aquifer and has closed a major community well field. At other sites, contamination has remained on site. Elevated levels of organics, including pesticides, and metal contaminants have been found in ground water and/or surface water at many sites.

A few examples of ecological damage were also identified. Impacts on fish or other aquatic life have been documented at 13 sites. Ecological damages associated with municipal solid waste landfills are difficult to identify and are often not investigated. Acute catastrophic impacts (e.g., a major fish kill) are not usually associated with municipal solid waste landfills. Municipal solid waste landfills are more likely to discharge contaminants to surface water that would cause subtle changes to the aquatic environment. Therefore, this small number of cases does not likely reflect

the actual number of occurrences. For example, a study conducted at one of the sites was specifically designed to determine what impacts a landfill had on benthic (bottom) organisms in a nearby stream. The results indicated that the diversity of benthic organisms downstream was much less than that found upstream. The few species that survived downstream were more tolerant of the higher metal concentrations from the landfill. Because these subtle changes would not have been identified during normal inspections, there are probably more cases of ecological damage from municipal solid waste landfills than the Agency has documented.

The case study information identifies several factors that may be related to failure at a particular facility. These factors include the landfill's age, location, and engineering design. However, it is not possible to isolate the specific factors responsible for each failure.

Superfund Statistics

In May 1986, EPA investigated characteristics of landfills then on the Superfund National Priorities List (NPL). To be listed on the NPL, a site must present or be capable of presenting significant environmental and/or human health impacts. Of the 850 sites listed or proposed for listing on the NPL in May 1986, 184 sites (22 percent) were identified as municipal solid waste landfills. Again, most of these municipal solid waste landfills were relatively old, but they can be used as indicators of potential problems for newer landfills. The appropriateness of the use of older sites as indicators of problems at newer municipal solid waste landfills was discussed previously.

Halogenated organics, aromatics, and metals were found at most of these sites. Releases of hazardous materials to ground water were documented at nearly 75 percent of the sites. Forty-three percent had releases to surface water, and 16 percent had significant air emission problems.

The costs associated with cleaning up ground-water contamination at Superfund sites may be staggering. For example, contamination from a 600-acre, unlined municipal solid waste landfill has closed two municipal wells

(120 million gallons/day). Cleanup costs will be in the tens of millions of dollars, which does not include the cost of replacing the lost water supply.

Methane Damage Cases

Methane is produced in municipal solid waste landfills through anaerobic decomposition of organic waste, and is explosive at sufficiently high concentrations (the lower explosive limit). This gas is produced in such abundance that methane collection projects are in place at approximately 100 landfills for the primary purpose of resource recovery and energy production. However, where methane is not controlled, it can cause fires and explosions.

In 23 of 29 damage cases studied, methane has been measured in concentrations above the lower explosive limit at distances up to 1,000 feet off site. On-site and off-site explosions and fires, have occurred in 21 of the 29 cases, loss of life has been documented in five instances, and injuries have been reported in several others. Most of these sites did not have a landfill gas control system installed before the incident.

Ground-Water Risk Assessment Indicates Potential for Human Health Risks and Significant Environmental Resource Damage.

To evaluate the human health risks and environmental resource damage associated with ground-water contamination at municipal solid waste landfills and to identify the factors that affect the nature, extent, and severity of impacts from these facilities, the "Subtitle D Risk Model" was developed. This model builds directly on the Subtitle C Liner Location Risk and Cost Analysis Model and includes information from case studies and the municipal solid waste landfill survey completed by EPA. The model includes a series of submodels that simulate pollutant release, fate, and transport; exposure; impacts; and corrective action. A summary of each of these submodels is presented in Volume II of this report.

There are several important caveats to the human health risk and environmental resource damage analysis results presented in this section. The model components introduce considerable uncertainty, particularly those that predict leachate quality for trace organics, the probability and

consequences of containment system failure, and the human health risk resulting from exposure to toxic substances (i.e., the dose-response models). Furthermore, the model does not analyze the risk and resource damage impacts from existing facilities. Rather, it estimates the effects from 6000 new facilities placed in existing landfill locations.

To characterize typical leachate from a municipal solid waste landfill, the Agency chose eight constituents from more than 200 chemical constituents found in municipal solid waste leachate. The eight constituents were selected because of their potential for causing human health risk or resource damage, given their observed concentrations in the leachate data, their toxicity to humans, their regulatory limits under the Safe Drinking Water Act, their taste and odor thresholds, and their mobility and persistence in the subsurface environment. The eight constituents and the effect of concern for each are as follows:

- Vinyl Chloride	human health risk (cancer)
- Arsenic	human health risk (cancer)
- Iron	resource damage (taste and odor)
- 1,1,2,2,-Tetrachloroethane	human health risk (cancer)
- Methylene Chloride	human health risk (cancer)
- Antimony	human health risk (systemic poison)
- Carbon Tetrachloride	human health risk (cancer)
- Phenol	resource damage (taste and odor)

Available data on leachate from municipal solid waste landfills are limited, especially for organics. The constituents and concentrations that best characterize the leachate are subject to change in the future as the data base is expanded. For this analysis, the median concentrations from the data base were used, but the Agency did consider using the 90th percentile concentration levels. The 90th percentile represents the higher end of the constituent concentrations for the leachate. It was estimated that the risk associated with the 90th percentile levels in the leachate data would be approximately one order of magnitude higher than that simulated for the median concentrations. The municipal solid waste landfill leachate data used for this analysis are presented in Chapter 4 of Volume II of this report.

The analysis estimates human health risk for the maximum exposed individual and the total population using ground water as a drinking water source within one mile of the facility. Model limitations do not allow the risk to be estimated at facilities with drinking water wells beyond one mile. Instead, the model assigns an exposure potential of zero to facilities with no drinking water well within one mile, which leads to a risk estimate of zero. Current data indicate that 54 percent of existing municipal solid waste landfills have no downgradient drinking water wells within one mile. Obviously, the risk results presented below are strongly influenced by this finding.

The surrounding climate and hydrogeology of a municipal solid waste landfill influence the rate at which pollutants are released and the transport of pollutants through the saturated and unsaturated zones. To incorporate these factors into the model, several environmental settings were defined that represent the range of hydrogeologic and climatic conditions in the United States. Net infiltration (precipitation minus evapotranspiration) and water table depth were used to define eight settings for the failure/release submodel (used to determine the pollutant release rate at a given facility). In addition, eleven generic ground-water flow fields were developed to model the transport of pollutants in the saturated zone. Once the environmental settings were established, EPA determined the distribution of landfills in each setting based on the mapping of a sample population of 700 landfills. This sample was assumed to be representative of the entire municipal solid waste landfill universe.

Using the well distribution indicated by the municipal solid waste landfill survey (i.e., no drinking water wells located within one mile of 54 percent of the landfills), the model estimates that across all 6,000 municipal solid waste landfills, approximately 17 percent have risks greater than 10^{-6} (i.e., an exposed individual would have a greater than one in one million chance of contracting cancer in his or her lifetime as a result of exposure). More specifically, 12 percent pose risk in the 10^{-6} to 10^{-5} range, and 5 percent pose risk in the 10^{-5} to 10^{-4} range. Out of the eight leachate constituents chosen, the three principal constituents contributing

to human health risk are vinyl chloride, 1,1,2,2,-tetrachloroethane, and dichloromethane.

For the subgroup of landfills located within one mile of a drinking water well (46 percent of all landfills), nearly 40 percent have risk exceeding 10^{-6}, with 14 percent posing risk in the 10^{-5} to 10^{-4} range. If future wells are located near existing municipal solid waste landfills (or new sites are located near current wells), the overall risk distribution may be closer to the estimates for this subgroup.

The overall risk distribution changes significantly if it is assumed that all drinking water wells are located at the facility boundary (assumed to be 10 meters from the landfill unit). This scenario, although certainly very conservative , helps to identify the number of landfills that may contaminate the ground water beneath the facility above health-based limits. Making this assumption, over 67 percent of the landfills would hypothetically pose risks exceeding 10^{-6}, with approximately 35 percent posing risks in the 10^{-5} to 10^{-4} range.

Because risk is the result of a complex interaction among many factors (some of which have not been accounted for in this analysis), no single factor is responsible for most of the variation. In addition to well distance, the results of the analysis identified other risk-contributing factors that include infiltration rate, facility size, and aquifer characteristics.

In addition to human health risk, resource damage of ground water was estimated. The risk portion of the model estimates the number of carcinogenic and noncarcinogenic human health effects. The resource damage submodel measures neither human health nor environmental impacts; rather, it is purely an economic measure of the loss in resource value when ground water is rendered unfit for human consumption. Human health risk and resource damage are mutually exclusive measures of impact and should not be added or combined in any fashion. Although both measures are based on human consumption of ground water, the health risk estimates are based on the risk to exposed populations without provision of alternative water supplies. The resource damage measure represents the cost of providing an alternative

water supply system. Resource damage was based on the cost (in present value terms) of replacing contaminated ground water that is currently used or that may be used for human consumption; nonconsumptive uses of ground water were not considered. Thus, the resource damage results reflect the potential growth in the future use of ground water as a drinking water source, while the human health risk estimates do not.

An important point concerning the resource damage estimates is the impacts of time and discounting. When considering the value of a resource, EPA has discounted future cash flows. As a result of this discounting, the timing of plume formation has a significant impact on the resource damage estimates. Thus, resource damage estimates for potential drinking water sources tend to be much lower than estimates for currently used drinking water primarily because of the discounting of future cash flows.

In present-value terms, the Agency estimates that resource damage from municipal solid waste landfills ranges from $0 to more than $4 million per site. The model predicts that nearly a third of the landfills would have resource damage exceeding $200,000, and about 13 percent have resource damage in excess of $1 million. The low present-value estimates for some facilities are the result of the finding that ground water is not currently used as a drinking water source at 54 percent of the landfills and, therefore, can only be considered a potential drinking water source.

As a second measure of resource damage, the model estimates the total area of contaminated ground water. The model estimates that the resulting total plume area from 6,000 new facilities placed in exisiting landfill locations would be roughly 1,114 square miles (an area slightly smaller than the state of Rhode Island) over the 300-year modeling period.

Waste, Leachate, and Gas Characteristics, Coupled with Poor Design and Operating Controls, Suggest Potential for Concern at Some Municipal Solid Waste Landfills.

Waste, Leachate, and Gas Characteristics

Municipal solid waste landfills receive a variety of wastes, as indicated in Table 4. While the overall waste stream is considered to be less hazardous than that received at RCRA Subtitle C (hazardous waste)

Table 4. WASTES DISPOSED OF IN A TYPICAL MUNICIPAL SOLID WASTE LANDFILL

Waste Types	Waste Composition Percentage[a] (mean value)
Household Waste	72
Commercial Waste	17
Construction/Demolition Waste	6
Industrial Process Waste	2.73
Other Waste	1.18
Sewage Sludge	0.50
Other Incinerator Ash	0.22
Asbestos-Containing Waste	0.16
Municipal Incinerator Ash	0.08
VSQG Hazardous Waste	0.08
Infectious Waste	0.05

SOURCE: Chapter 4 of Volume II of this report.

[a] Percentages are rounded and do not add to 100 percent.

facilities, it nevertheless is a source of concern. By far, the majority of waste disposed of at municipal solid waste landfills is household waste (72 percent of the total waste stream). Household waste is primarily made up of nonhazardous materials such as paper. Some nonhazardous material, however, may contain hazardous constituents, such as, lead in newsprint. In addition, within a landfill, some of these nonhazardous materials may degrade biologically and/or chemically and form more toxic constituents. Further study is needed in this area because current data are extremely limited. Also, about 0.35 to 0.40 percent of the overall household waste stream includes hazardous components. Constituents of concern in household hazardous waste include solvents, pesticides, other organics, acids, bases, medicines, and inks (see Exhibit 2).

If misused or improperly stored or disposed of household hazardous waste may seriously harm homeowners, solid waste collection personnel, and the environment. A small portion of household hazardous waste is collected

Exhibit 2. HOUSEHOLD HAZARDOUS WASTES AND THEIR CHARACTERISTICS

Household Cleaners
Drain openers (C)
Oven cleaners (C)
Wood and metal cleaners and polishes (I)
Toilet bowl cleaners (C)
General purpose cleaners (C or I)
Disinfectants (C or I)
Automotive Products
Oil and fuel additives (I or E)
Grease and rust solvents (I)
Carburetor and fuel-injection cleaners (I)
Air conditioning refrigerants (Listed)
Starter fluids (I or Listed)
General lubricating fluids (I or E)
Radiator fluids and additives (I)
Waxes, polishes, and cleaners (I or C)
Body putty (I)
Transmission additives (I)
Home Maintenance Products
Paint thinners (I)
Paint strippers and removers (I)
Adhesives (I)
Paints (I)
Stains, varnishes, and sealants (I)
Lawn and Garden Products
Herbicides (E or Listed)
Pesticides (E or Listed)
Fungicides or wood preservatives (Listed)
Miscellaneous
Batteries (C or E)
Fingernail polish remover (I)
Pool chemicals (R)
Photo processing chemicals (E, C, or I)
Electronic items (E)

SOURCE: Chapter 3 of Volume II of this report.

C: Corrosive
E: EP toxic
I: Ignitable
Listed: Toxic or acutely toxic
R: Reactive

by special programs instead of being disposed of in municipal solid waste landfills (or municipal sewer systems). The number of these programs is steadily increasing. They not only ensure the safe collection and disposal of these wastes, but also increase public awareness of hazardous materials.

The other 28 percent of wastes received at municipal solid waste landfills includes very-small-quantity generator (VSQG) hazardous waste, commercial waste, industrial process waste, infectious waste, municipal incinerator ash, and asbestos-containing wastes. Some of these waste streams may contain potentially hazardous constituents. Because the actual waste composition at individual municipal solid waste landfills may vary a great deal from that presented in Table 4, some municipal solid waste landfills may contain greater amounts of these waste streams. Congress, in the 1984 amendments to RCRA, was particularly concerned with VSQG waste. This waste stream accounts for a small part of the overall waste stream received at municipal solid waste landfills; however, some relatively hazardous or toxic materials are present in the VSQG waste stream (see Exhibit 3). Used lead acid batteries are the largest single source of VSQG waste. Municipal solid waste combustion ash and infectious wastes are discussed later in this report.

Included in these waste streams are some PCB materials that the regulations under the Toxic Substances Control Act allow to be disposed of in municipal solid waste landfills. Specifically, the PCB regulations allow certain classes of materials with PCB concentrations greater than 50 ppm to be handled as Subtitle D wastes. These materials include nonleaking small capacitors, equipment that contains small capacitors (e.g., microwave ovens, air conditioners, fluorescent light ballasts), certain drained and flushed hydraulic machines, and other articles that once contained less than 500 ppm of PCBs.

EPA was able to gather data on the chemical characteristics of leachates from 70 municipal solid waste landfills (complete summary tables of these data are contained in Volume II of this report). These data represent the work of a number of separate investigations that had different objectives and methods. For example, the list of chemical constituents analyzed for in the various investigations varied significantly. Of the 70

Exhibit 3. CATEGORIES OF VERY-SMALL-QUANTITY GENERATOR WASTES

Arsenic waste	Photographic wastes
Cyanide wastes	Solutions of sludges containing silver
Dry cleaning filtration residues	Solvent still bottoms
Empty pesticide containers	Spent plating wastes
Heavy metal dust	Spent solvents
Heavy metal solutions	Strong acids or alkalies
Heavy metal waste materials	Used lead-acid batteries
Ignitable paint wastes	Waste formaldehyde
Ignitable wastes	Waste inks containing flammable solvents or heavy metals
Ink sludges containing chromium or lead	Waste pesticides
Mercury wastes	Wastes containing ammonia
Other reactive wastes	Wastewater containing wood preservatives
Paint wastes containing heavy metals	Wastewater sludges containing heavy metals
Pesticide solutions	

SOURCE: Chapter 3 of Volume II of this report.

sites for which EPA has data, 53 of them were analyzed for some organic constituents, and 62 for some inorganic constituents. Other important caveats to these data are that EPA does not have complete information on the age, location, design and operating characteristics, or waste characteristics of the landfills from which the data come. Also, other research has shown that the quality of leachate from municipal solid waste landfills changes over time as a landfill stabilizes. As a result, conclusions about the characteristics of municipal solid waste leachate based on these data must be carefully drawn.

Despite these limitations, the data may be used to formulate some general observations. A total of approximately 82 leachate constituents were found--63 organics and 19 inorganics. Both the occurrence and concentration of these constituents appear to vary widely. The concentration of inorganic constituents seem especially variable. Municipal solid waste leachate is generally highly concentrated with the common salts, total organic carbon, and total solids.

To provide some reference point for the risk associated with these leachate constituents, the median concentration values of the leachate constituent data were compared to EPA drinking water and/or human health criteria concentrations. This is a very conservative analysis, since in all but the most extreme circumstances municipal solid waste landfill leachates will become highly diluted in ground water. The median concentrations of all the carcinogens (nine constituents) were above the health-based criteria for these compunds. In a number of cases, the median concentrations would take more than a 1000-fold dilution in order to meet the health criteria. This analysis indicates that some contaminants are of potential concern.

EPA also attempted to identify any differences in quality between leachate from pre- and post-1980 landfills. Any changes in the leachate quality over this time frame may be the result of the Federal regulatory program, as discussed previously. This analysis is highly tenuous because post-1980 data are limited. In addition, leachate quality tends to change over time as the landfill moves through the stabilization process. However, where leachate data are available for both pre- and post-1980 landfills, no trend is apparent. Median concentrations for leachate from post-1980 landfills are higher than those for pre-1980 landfills for approximately 50 percent of the constituents. The Agency plans to initiate additional field sampling that will focus on post-1980 landfills to supplement the data base.

Landfill gas adds to the potential for impacts from municipal solid waste landfills, as demonstrated by the damage cases previously discussed. Methane, which is explosive, accounts for about 50 percent by volume of the total gas stream. Carbon dioxide accounts for most of the remaining portion of landfill gas; however, trace constituents (up to 2 percent) of volatile organic compounds (VOCs) and toxic constituents also may be present. Toxic constituents commonly found in municipal solid waste landfill gas include vinyl chloride, benzene, trichloroethylene, and methylene chloride. The Agency is currently preparing to propose standards controlling these air emissions under Section III of the Clean Air Act.

Design and Operating Controls

Use of design and operating controls at municipal solid waste landfills is limited (see Table 5). Recalling the factors of concern found in the review of the damage cases as well as the risk assessment study (e.g., close proximity to the ground-water table, absence of liners), the statistics presented here are indicative of the prevalence of conditions that may result in contamination at some municipal solid waste landfills. Available data on waste, leachate, and gas characteristics support this possibility.

Municipal Solid Waste Disposal Is Perceived to Be an Environmental Problem on Indian Lands.

At present, there are 314 Federally recognized Indian Tribes and 198 Alaskan Native villages in the United States covering an area of approximately 87,000 square miles, or an area equivalent to that of the New England States, plus New Jersey, Delaware, and Maryland. The total population on this land is approximately one million. The Indian Health Service (IHS) has identified 576 municipal solid waste disposal sites on Indian lands. This does not include roadside dumping or other dumping.

Several EPA-sponsored surveys indicate that Indian Tribes perceive municipal solid waste disposal as a current and future environmental problem. One survey reported that on half of the reservations surveyed (24) "community dumps" were used for disposal. Another reported 66 open dumps on Indian lands in EPA's Region 5 alone. Roadside dumping and other illegal dumping were also reported. Landfill leachate was cited several times by the Tribes surveyed as the potential source of water pollution. Because current data are limited, additional information is necessary to determine whether a threat to human health and the environment exists.

The types of solid waste disposal problems that have been cited on Indian lands are similar to those found in small rural communities. However, while the approach to implementing a solid waste program in rural communities is clearly defined under RCRA, the approach for Indian lands is not clear. (This is discussed further in Volume II and Section III of this Volume).

Table 5. DESIGN AND OPERATING CONTROLS AT ACTIVE MUNICIPAL SOLID WASTE LANDFILL UNITS

Design and Operating Controls	Census Data[a]	Survey Data[a]
Synthetic liners	71 (0.8%)	73 (1.1%)
Natural liners (e.g., clay), including slurry walls	1,353 (14.6%)	1,806[b] (27.3%)
Leachate collection systems	481 (5%)	1,423 (21.7%)
Run-on/run-off controls	4,240 (45.7%)	4,016 (61.0%)
Methane controls (vents, recovery)	1,539 (16.6%)	123[c] (1.9%)
Restrictions on receipt of liquid wastes (e.g., bulk liquid restrictions)	4,436 (47.8%)	No Data

SOURCE: Chapter 4 of Volume II of this report.

Note: Percentages given are percent of total units.

[a] Census data includes 9,284 municipal solid waste landfill units and the Survey includes 6,584 units.
[b] Only in-situ clay liners are identified for this entry.
[c] Survey results estimate only the number of recovery systems.

Industrial Subtitle D Facilities

Industrial Subtitle D facilities discussed in this section include landfills, surface impoundments, land application units, and waste piles. As described in the profile, the number of these facilities is very large, and the total amount of waste they handle dwarfs that managed in municipal solid waste landfills. Available characterization data are more limited than those available for municipal solid waste landfills. Case study information, NPL statistics, leachate characteristics, and risk assessment data are <u>not</u> available for industrial facilities. Therefore, it is not possible to draw conclusions regarding industrial Subtitle D facilities with the degree of confidence possible in evaluating municipal solid waste landfills. Existing data do suggest, however, that industrial Subtitle D facilities are a cause for concern.

Large Waste Volumes and Number of Units Suggest Cause for Concern and Need for Further Investigation.

Table 6 shows that over 27,000 industrial Subtitle D units handled over 7 billion tons of industrial waste generated in 1985. In addition, the waste streams are very diverse--from potentially hazardous to potentially benign. Information on the actual characteristics of each of the 17 industrial waste categories is limited. Thus, conclusions regarding leachate conditions and possible impacts cannot be drawn until this area is studied further. Nevertheless, the large volume of wastes and large number of units present concerns regarding potential human health and environmental impacts.

More than half the units are surface impoundments, which handle a large portion of all waste disposed of in industrial Subtitle D facilities. This large number of surface impoundments may be cause for concern because of the mobility and physical driving force of liquids in impoundments and the sporadic use of design controls (described below). However, current limited knowledge of the characteristics of waste disposed of or stored in impoundments does not allow conclusions to be drawn.

Limited Use of Design Controls and Occurrence of Violations Are Causes for Concern.

Study results indicate only sporadic application of design and operating controls at industrial landfills and surface impoundments. As indicated in Table 7, only 12 percent of industrial landfills and 22 percent of industrial surface impoundments have any type of liner system. In addition, run-on/run-off controls and liquids restrictions are employed at fewer than 35 percent of all industrial landfills.

The number of industrial landfills, surface impoundments, and land application units cited for violations of State standards in 1984 is presented in Table 8. As discussed earlier in the municipal solid waste landfill section, violations vary in meaning and severity and are not always indicative of severe environmental impacts. Table 8 indicates that few violations were reported; however, few facilities have monitoring systems,

Table 6. NUMBER OF INDUSTRIAL SUBTITLE D UNITS AND 1985 WASTE QUANTITIES DISPOSED OF IN THEM

Industry Type	Type and Number of Active Industrial Subtitle D Units and (1985 Waste Quantities Disposed of in Thousand Tons)				
	Landfills	Surface Impoundments	Land Application Units	Waste Piles	Totals[a,b]
Organic Chemicals	17 (263)	262 (56,727)	27 (1,827)	79 (48)	385 (58,864)
Primary Iron and Steel	201 (3,687)	383 (1,290,649)	76 (76)	464 (6,129)	1,124 (1,300,541)
Fertilizer and Agricultural Chemicals	31 (5,789)	274 (154,257)	160 (756)	50 (4,820)	515 (165,623)
Electric Power Generation	155 (53,449)	1,220 (1,037,665)	43 (331)	110 (832)	1,528 (1,092,277)
Plastics and Resins Manufacturing	32 (86)	292 (177,241)	17 (1,166)	32 (3,018)	373 (180,510)
Inorganic Chemicals	120 (3,220)	1,039 (875,075)	24 (108)	98 (41,323)	1,281 (919,725)
Stone, Clay, Glass, and Concrete	1,257 (7,571)	3,152 (605,168)	309 (51)	2,528 (9,184)	7,247 (621,974)
Pulp and Paper	259 (5,873)	118 (2,235,418)	139 (8,942)	232 (1,469)	748 (2,251,700)
Primary Nonferrous Metals	111 (1,375)	448 (56,559)	9 (373)	312 8,764	880 (67,070)
Food and Kindred Products	194 (3,595)	4,166 (293,524)	3,128 (75,938)	540 (460)	8,029 (373,517)
Water Treatment	121 (157)	659 (49,724)	147 (8,955)	48 (9)	974 (58,846
Petroleum Refining	61 (272)	915 (167,885)	144 (396)	158 (79)	1,278 (168,632)
Rubber and Misc. Products	77 (520)	176 (23,567)	16 (52)	123 (58)	392 (24,198)
Transportation Equipment	63 (172)	287 (11,789)	11 (0.33)	362 (708)	723 (12,669)
Selected Chemicals and Allied Products	21 (112)	219 (62,440)	17 (428)	41 (8)	298 (62,987)
Textile Manufacturing	28 (69)	741 (252,931)	72 (763)	103 (18)	944 (253,780)
Leather and Leather Products	9 (9)	102 (3,214)	0 (0)	54 (11)	164 (3,234)
Totals[a,b]	**2,757 (86,219)**	**15,253 (7,353,834)**	**4,308 (99,160)**	**5,335 (76,936)**	**27,654 (7,616,149)**

SOURCE: Chapter 4 of Volume II of this report.

[a] Table entries may not add up to their respective totals because of rounding.

[b] Units identified by the 1986 Industrial Survey.

Table 7. DESIGN AND OPERATING CONTROLS EMPLOYED AT INDUSTRIAL SUBTITLE D FACILITIES

Design and Operating Controls	Facility Type		
	Landfills[a]	Surface Impoundments[a]	Land Application Units[a]
Synthetic liners	45 (1.3%)	756 (4.7%)	NA
Natural liners (e.g., clay), including slurry walls	392 (11.2%)	2,818 (17.4%)	NA
Leachate collection systems	112 (3.2%)	NA	NA
Leak detection systems	UNK	896 (5.5%)	NA
Runon/runoff controls	1,150 (32.8%)	UNK	3,837 (68.5%)
Overtopping controls	NA	3,672 (23%)	NA
Methane controls (vents, recovery)	98 (2.8%)	NA	NA
Restrictions on receipt of liquid wastes (e.g., bulk liquid restrictions)	1,200 (34.2%)	2,685 (17%)	3,633 (64.8%)
Discharge permits	UNK	4,738 (29.2%)	UNK
Waste application rate limits	NA	NA	4,085 (72.9%)
Restrictions on the growing of food chain crops	NA	NA	2,395 (42.7%)

SOURCE: Chapter 4 of Volume II of this report.

Note: Percentages given are percent of total units.

NA = Not Applicable.

UNK = Unknown, data are not available.

[a] Includes 3,511 landfills, 16,232 surface impoundments, and 5,605 land application units identified by the 1984 State census.

Table 8. VIOLATIONS OF STATE STANDARDS DETECTED AT INDUSTRIAL SUBTITLE D FACILITIES IN 1984

Medium of Concern	Landfills		Surface Impoundments		Land Application Units	
	Facilities w/ Monitoring	Number of Facilities With at Least One Violation	Facilities w/ Monitoring	Number of Facilities With at Least One Violation	Facilities w/ Monitoring	Number of Facilities With at Least One Violation
Ground Water	626	111	1,396	416	592	45
Surface Water	230	50	3,151	279	137	60
Air	80	18	73	145	31	10
Methane (Subsurface Gas)	63	8	--	--	--	--
Soil	--	--	--	--	204	--
Total Active Facilities[a]	3,511		16,232		5,605	

SOURCE: Chapter 4 of Volume II of this Report.

[a] Facilities identified by the 1984 State Census.

and only 35 percent of the industrial facilities were inspected in 1984. Therefore, actual numbers of violations may be higher.

While both the violation data and statistics on design and operating controls suggest that releases may be occurring in all media, further data are needed to determine the impacts of industrial Subtitle D facilities. To address this concern, EPA will propose to amend the current Subtitle D Criteria (40 CFR Part 257) to include a notification requirement for industrial facilities and to develop a plan for filling remaining data gaps. Also, efforts are planned to gather additional environmental monitoring data to determine potential environmental impacts, with particular emphasis on ground water. These data will be used to support risk assessments of industrial Subtitle D wastes and facilities.

C. Special Subtitle D Wastes

Several Subtitle D waste streams pose special management concerns. These concerns arise from the unique characteristics of the wastes. Current data are not sufficient to estimate reliably the risks posed by these wastes. However, additional data collection and analysis should help define appropriate management strategies for these wastes. For a more complete discussion of these waste streams, see Chapter 3 of Volume II.

Waste Tires

The disposal of scrap tires is a very difficult problem across the United States. The U.S. Department of Energy estimates that of the 240 million tires discarded each year, 168 million tires are disposed of in landfills or junkyards. These scrap tires provide an excellent breeding ground for vermin and mosquitoes. In the United States, at least four species of tire-breeding mosquitoes have been identified. These mosquitoes transmit diseases such as Dengue fever, LaCrosse encephalitis, and St. Louis encephalitis. The Department of Energy identified 34 stockpiles that contain at least 100,000 tires and are within 150 miles of a major metropolitan area. Many more smaller piles were also identified. These large tire stockpiles may pose serious public health hazards. The management of scrap tires will be addressed by EPA's Municipal Solid Waste Task Force as part of the development of the national strategy for the management of municipal solid waste.

Infectious Waste

An infectious waste is a waste that contains pathogens of sufficient virulence and quantity so that exposure to the waste of a susceptible host could result in an infectious disease. Six categories of infectious waste have been identified by EPA, including contaminated sharps, isolation wastes, and pathological wastes. Approximately 5,900 tons of infectious hospital waste are produced each day. Proper handling, treatment, and disposal of these wastes are essential. Guidelines for infectious waste management were published by EPA in 1986. EPA recommends that only treated

infectious waste be disposed of in a municipal solid waste landfill (treated infectious waste is no longer infectious). If untreated infectious waste is landfilled, personnel handling these wastes should use extreme care, and State officials and landfill operators should be consulted before shipping the wastes to the facility. To date, no ground-water impacts associated with the land disposal of infectious waste have been identified.

Municipal Solid Waste Combustion Ash

Interest in municipal solid waste combustion has grown dramatically in the last several years because of the limited landfill capacity in certain areas of the nation and the difficulty in siting new landfills. In 1988, approximately 3 to 8 million tons of ash were produced by the combustion process. Heavy metals such as lead have been found at elevated levels in ash leachate samples. The combustion process concentrates heavy metals in the ash. These findings have raised concerns regarding the proper disposal of the ash. Leachates from some municipal solid waste landfills are slightly acidic. Acidic leachate would increase the mobility of the heavy metals in the ash. EPA is currently in the process of determining the appropriate controls necessary for the management of municipal waste combustion ash.

D. Factors Contributing to Impacts

Regulations (State and Federal), State implementation of the regulations, and inadequate Federal technical assistance may be contributing to the potential long-term human health impacts and environmental impacts from some municipal solid waste landfills that have been identified in this report. In general, EPA found that both State and Federal regulations and State implementation were inadequate. In addition, Federal technical assistance in the 1980's has been very limited.

Adequacy of State and Federal Regulations

A key role for the Federal government in the Subtitle D program is providing regulatory direction to the States. In fulfillment of this role, EPA developed the current Subtitle D criteria (40 CFR Part 257), which are

minimum national performance standards for the protection of human health and the environment from solid waste disposal facilities. The States use these criteria when developing their own solid waste regulations to ensure that their regulations are at least as stringent as the Federal criteria. Therefore, EPA's first step in evaluating the Federal criteria was an evaluation of State solid waste regulations. If EPA found all State regulations to be adequate, it would assume that the Federal criteria are providing appropriate regulatory direction to ensure protection of human health and the environment. On the other hand, inadequate State regulations would suggest possible inadequacies in the Federal criteria. Only regulations for municipal solid waste landfills are discussed below because impacts have not been documented for other Subtitle D facilities.

Regulations For Municipal Solid Waste Landfills Addressing Location, Design, Operation, and Closure and Post-Closure Care Are Necessary to Ensure Protection of Human Health and the Environment.

To evaluate the adequacy of current State and Federal regulations, the Agency determined what regulations (if properly implemented and enforced) would be necessary to ensure that municipal solid waste landfills do not adversely affect human health or the environment. EPA believes that properly located, designed, and operated municipal solid waste landfills are protective of human health and the environment. The Agency believes that the data presented earlier in this report point to the need for regulatory provisions addressing municipal solid waste landfill location, design, operation (including ground-water monitoring and corrective action), and closure and post-closure care (including financial responsibility). The Agency recognizes, however, that these regulatory provisions should allow for consideration of site-specific conditions in establishing specific facility requirements.

With regard to location restrictions, EPA believes that unstable areas, such as those prone to subsidence, may present significant obstacles to proper waste containment. Thus, regulations should minimize waste disposal activities in these areas, as well as in wetlands and other sensitive environments, to help prevent ground-water contamination.

Proper design of a municipal solid waste landfill can play a role in minimizing the risks posed by the facility. In certain locations a liner and a leachate collection system will help prevent ground-water and surface water contamination. Because what is considered to be an appropriate design is location-dependent, regulatory provisions for design should allow for site-specific considerations.

Operating controls, including general management practices, ground-water monitoring, and corrective action, are necessary to protect public health and the environment. Ground-water monitoring is necessary to determine if contamination is occurring and, if it has occurred, to what extent. Because the majority of existing municipal solid waste landfills do not monitor the ground water, the number of facilities that have contaminated the ground water is unknown. These facilities need to be identified. Once ground-water contamination is identified, corrective action requirements are needed to ensure that the ground water is cleaned up. While ground-water contamination exists, owners and operators should be required to ensure that public health and the environment are protected.

Other types of requirements necessary to protect human health and the environment from impacts associated with municipal solid waste landfills are closure and post-closure care requirements. Current experience clearly indicates the importance of proper closer procedures, including proper final cover at municipal solid waste landfills to minimize threats to ground water. Post-closure care requirements ensure that after closure the owner or operator properly monitors and cares for the facility. Superfund experience indicates that some impacts do not become evident until after a facility closes. Finally, because the costs of proper closure and post-closure care are high, financial responsibility requirements are necessary to ensure that the owner or operator is financially capable of carrying out these activities.

Some State Solid Waste Regulations Are Incomplete.

State solid waste regulations were examined for the specific requirements discussed above. While a few States had comprehensive

regulations, the majority of States had inadequacies in one or more areas. Only a few States included location standards for wetlands (6 States), seismic impact zones (3 States), and subsidence-prone areas (6 States) in their Subtitle D regulations. Most States however, restrict siting in floodplains. Twenty-four States included provisions for appropriate design of a landfill. Thirty-eight States require ground-water monitoring by regulation, and an additional 12 States have general authority to impose ground-water monitoring on a site-specific basis. Twenty-one States have corrective action requirements in their regulations. Nearly all the States (49) require a final cover at closure, and 42 States require post-closure care. However, the post-closure care requirements vary tremendously. Some States specify a very short post-closure care period (e.g., 1-5 yrs), while other States require a more extensive period (e.g., 20 yrs). Finally, 20 States require some form of financial assurance. From this review, it can be seen that on a national basis, States' regulations do not include important provisions. Because of this variation in State regulations, the extent to which a particular municipal solid waste landfill is located, designed, and operated in a manner that is protective of human health and the environment is strongly dependent on the political entity in which it resides.

The Current Federal Subtitle D Criteria Lack Some Essential Requirements.

Because the Federal criteria should form the basis of State solid waste regulations, inadequacies in State regulations suggest that the Federal criteria may not be complete. Therefore, EPA evaluated the existing Federal criteria in the same manner as the State evaluation.

The existing Federal criteria restrict facility siting in floodplains, but inadequately address other locational concerns (e.g., wetlands, seismic impact zones). While the Federal criteria clearly prohibit contamination of an underground drinking water source beyond the waste management unit's boundary (or alternative boundary set by the State), they do not mention the need to consider appropriate design, nor do they require any monitoring for determining whether such contamination exists. The Federal criteria also lack corrective action requirements and do not contain any provisions related to closure, post-closure care, or financial responsibility.

State Implementation of State Regulations

Although inadequacies in Federal and State regulations were found to contribute to the problems associated with municipal solid waste landfills, State implementation (including enforcement) of State regulations must also be examined to determine what, if any, role it has played. For example, as mentioned previously, 38 States require ground-water monitoring in their solid waste regulations; however, ground-water monitoring is not conducted at 65 percent of municipal solid waste landfills. Therefore, State implementation appears to be at least partially responsible for the current lack of ground-water monitoring.

While only regulations for municipal solid waste landfills were evaluated in the previous section, this section discusses the implementation of requirements for all Subtitle D facilities. The discussion includes an evaluation of State enforcement authorities, resources, organization, and planning . While this study found that some States had significant deficiencies in implementation programs for Subtitle D facilities, it also found that many States are taking steps to correct these deficiencies. The State's best efforts concern municipal solid waste landfills; however, even for these facilities, there is room for improvement.

Some States Have Incomplete Enforcement Authorities.

Although the basic solid waste enforcement frameworks are in place in most States, the scope of existing State authorities does not include all types of Subtitle D facilities, wastes, and practices. Although some States' solid waste regulations may be enforced through devices such as citizen suits or may be self-implementing, EPA believes that the permit process or other system of prior approval is a more effective means of enforcing standards.

Every State currently can regulate Subtitle D facilities by issuing permits; however, permits are not required for all types of Subtitle D facilities. All States have permit requirements or other systems of prior

approval for municipal solid waste landfills and nearly 60 percent of the municipal solid waste landfills have permits or approved plans. However, fewer than half the States require them for other facilities (e.g., surface impoundments, land application units, waste piles). In fact, only 10 States have permit requirements for all Subtitle D facilities. States devoted the largest proportion of total hours spent on Subtitle D activities (70 percent) toward surveillance/enforcement and permitting. However, 50 percent of all Subtitle D facilities are operating without a State permit.

Landfills and surface impoundments have been the primary focus of State inspection efforts. Landfills are inspected more often than any other type of facilities, with municipal solid waste landfills receiving most of the attention. Nearly 75 percent of all municipal solid waste landfills are inspected at least once a year. In addition, approximately half of all surface impoundments are inspected yearly or more often. On the other hand, approximately 70 percent of all land application units are inspected less than once every two years. In 1984, over 15,000 violations were detected at Subtitle D facilities. However, it is estimated that less than 20 percent of these violations resulted in formal State actions. The relatively low percentage of State actions is probably due to both limited resources and limited enforcement authorities.

Some State Program Organizations Are Fragmented.

Most States have from two to eight different agencies administering different parts of the Subtitle D program. Landfills are generally administered by solid waste agencies, surface impoundments by water agencies, and land application units by either agency. Program organization can be a problem in some States because some facilities may have no agency involvement, while others may have several. For example, in some States, one agency may be responsible for permitting a facility while another one is responsible for inspecting the same facility. Where multiple agency administration is desirable, extra effort should be taken to organize and coordinate the State's Subtitle D responsibilities.

State Subtitle D Program Resources Are Limited.

In 1984, the total Subtitle D program budget for all States was slightly less than $40 million and 1.8 million labor-hours for a universe of slightly more than 227,000 Subtitle D units. Each State or territory must therefore oversee thousands of units on an average annual budget of approximately $800,000 and 18 full-time equivalents. This corresponds roughly to $200 and 8 labor-hours per unit per year. In addition, program resources showed large variations from State to State. Most of the States (28) budgeted less than $500,000 for Subtitle D activities. There were, however, a few States (7) that each spent more than $1 million on Subtitle D activities.

Federal funding accounted for approximately 30 percent of the State Subtitle D budget in 1981 and for approximately 7 percent in 1984; this limited Federal funding supported State water programs. States have partially made up for this decrease in funding by an increase in facility fees and permit charges. In addition, a few agencies have a unique budget for Subtitle D activities; it appears that resources are diverted from other programs to offset this lack of funds.

Long-Term Planning By States Is Inadequate.

Long-term planning should be an important part of any solid waste management program. Some data suggest that States are not planning adequately for future needs, particularly with respect to municipal solid waste disposal. For example, as noted earlier, data indicate that approximately three-fourths of the existing municipal solid waste landfills will run out of capacity in fifteen years; yet very few new waste management facilities have been established. EPA fully recognizes that long-term planning is significantly hampered by public concern over the siting of new waste management facilities.

Federal Technical Assistance

Federal Technical Assistance on Solid Waste Management Has Been Limited.

In addition to providing minimum national standards for Subtitle D facilities, EPA is also charged with providing technical assistance and guidance to the States for planning, developing, and implementing Subtitle D programs. Since 1980, there has been only very limited technical assistance by the Federal government in implementation of the Subtitle D program at the State and local levels. In fact, the last guidance document prepared by EPA with specific application to Subtitle D was issued in 1979. Increased technical assistance could enhance effective State execution of the Subtitle D program.

D. Recommendations for State and Local Action

States Should Quickly Adopt New Federal Criteria as Required by HSWA.

The Agency recognizes that some States have already taken steps to improve their Subtitle D programs and that others are waiting for new regulatory direction from the Federal government. As the Federal government develops new Federal criteria and policies, States should adopt them so as to realize their beneficial effects as quickly as possible.

State and Local Governments Must Ensure the Vitality of Their Subtitle D Programs.

State Subtitle D programs must encompass all Subtitle D facilities, not just municipal solid waste landfills. To do this, most State and local budgets and staffs will need to be increased. State and local governments need to explore alternate sources of funding to establish a dependable future source of income. The development of a permitting or annual fee system as an example of such alternative funding. Enforcement authorities should be strengthened as necessary to ensure that State regulations can be properly and effectively enforced and that all facilities are permitted and inspected regularly. States may be able to increase their capacity to detect and prosecute certain Subtitle D facility violations by authorizing local public health departments to identify such violations.

State and Local Governments Should Carefully Plan for Solid Waste Management.

To effectively manage the wastes generated in this nation, each State must carefully develop a comprehensive solid waste management program that captures the spirit of the national policy, including the use of source reduction, recycling and the use of recycled materials, energy recovery, and environmentally sound land disposal for the residual waste. To facilitate State planning, local governments must cooperate in assessing solid waste handling needs and capabilities into the future.

E. Recommendations for Legislative Changes

HSWA included many changes to Subtitle D of RCRA. However, the Federal and State roles established by RCRA were left intact. EPA supports the continuation of these roles.

Current limited data do not indicate the need for additional enforcement authorities beyond those provided by HSWA for solid waste disposal facilities that receive HHW and SQG waste, including municipal solid waste landfills. The Agency may revisit this issue for other Subtitle D facilities, such as industrial landfills and surface impoundments, as more data are collected and analyzed on these facilities. In addition, most of the HSWA provisions (e.g., the Federal discretionary enforcement authority) pertaining to facilities that receive household hazardous waste and small-quantity generator hazardous waste will not be effective until after EPA revises the current criteria (i.e., not before 1989). Because these provisions have not had an opportunity to function yet, it is difficult to determine what direction any new amendments should take. However, in order to best implement the recommendations presented above for State and Federal action, EPA believes the following legislative changes are necessary.

Clarify EPA's Authority for Developing Standards Under Subtitle D for Closed Facilities.

The intent of the existing language in Subtitle D of RCRA regarding regulation of closed solid waste facilities is unclear. At this point, EPA is uncertain whether its authority is limited to regulating the active disposal of solid waste (i.e., only operating facilities). As such, closed facilities will not be covered by the upcoming Subtitle D criteria revisions.

EPA is planning to examine the risks posed by, and the need for remedial action at, closed facilities, in part because of the concern that some closed facilities may have received large quantities of hazardous waste before 1980, and may pose a threat to human health and the environment. Closed disposal facilities (under both Subtitle D and C) that pose the

greatest risk to human health and the environment are typically dealt with under the Superfund program.

Clarify the Definition of "Indian Tribes" Under RCRA.

Under Subtitle A, Section 1004 of RCRA, Indian Tribes (including authorized Tribal organizations and Alaskan Native Villages) are included under the definition of a municipality. While a municipality plans and implements its own solid waste management program, it is subject to State solid waste regulations and State solid waste management objectives. Therefore, defining an Indian Tribe as a municipality implies that Tribes are a political subdivision of the State. However, this interpretation is contrary to treaty obligations of the United States with the majority of Tribes and is in direct conflict with the Indian Self-Determination and Education Act, other pieces of EPA authorizing legislation (e.g., the Clean Water Act, the Safe Drinking Water Act, and the Superfund Amendments and Reauthorization Act), and the Presidential Indian Policy, which stress Indian sovereignty and self-government.

To clarify this situation, EPA recommends that RCRA be amended to include provisions similar to those under Section 1451 of the Safe Drinking Water Act. This section authorizes the EPA Administrator to treat Indian Tribes as States. However, it also requires the Administrator to define by regulation when Tribes will be treated as States and, where that is inappropriate or infeasible, how the goals of the Act will be met.